WFPC2 Cycle 4 Calibration Summary

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ABSTRACT
The Cycle 4 Calibration program was executed from late Spring 1994 through early Summer 1995. The main purpose of the Cycle 4 programs was to provide calibration for all Cycle 4 GO/GTO science programs as well as to monitor the health and photometric stability of the instrument. This report summarizes the proposals executed, products generated from the data including a full list of Documentation, and work in progress to complete the Cycle 4 calibration goals.

1. Introduction
The Cycle 4 calibration program was designed to follow the WFPC2 IDT’s SMOV program (Science Mission and Orbital Verification, performed late 1993 to late spring 1994 after the installation of WFPC2). While the SMOV programs provided initial in-flight verification of the instrument’s performance and optical alignment as well as an initial photometric calibration (with a limited filter set), the Cycle 4 program was designed to provide calibration for all Cycle 4 GO/GTO science programs as well as monitor the health and safety of the instrument during the cycle.

Because WFPC2 was essentially a new instrument, different from WF/PC in many major areas - especially optics train and detectors - the calibration plan was designed to be flexible and to accommodate changes in our understanding of the instrument. Major variations with respect to the original plan were the change in operating temperature on April 23, 1994, to reduce the CTE effect discovered early during SMOV, and the increased rate of decontaminations, necessary because the rate of deposition of contaminants proved higher than expected.

Photometric calibration was carried out in a number of ways. The overall throughput calibration was verified and its stability monitored through frequent observations of a spectrophotometric standard, white dwarf GRW+70D5824 (proposal 5563), using the standard photometric filters (F336W, F439W, F555W, F675W, F814W) and several UV
filters. The UV throughput was also monitored on a weekly basis using F170W (proposal 5629). The throughput of the four CCD was compared by observing the standard star in all four cameras using the standard photometric filters (proposal 5564).

More detailed photometric calibrations, including color terms for a range of stellar types, were obtained using a standard field in Omega Cen (proposals 5565/5663); ground-based observations using spare WFPC2 filters were carried out by the WFPC2 IDT in conjunction with this proposal. A sweep of all filters using the photometric field was also obtained (5572). Two specific proposals were devoted to the quantitative characterization of the CTE problem discovered during SMOV: a large-angle dither test (proposals 5646 and 5659) and a preflash test, which unfortunately did not give useful results (proposal 5632).

The other major area of calibration was the monitoring of the health and stability of WFPC2 through internal images. This included: biweekly internal images to monitor the stability of the camera electronics and alignment, consisting of biases, INTFLATS, Kelsall spots (proposal 5560); internal flat fields using the visible and UV calibration channels, to monitor camera throughput and as an additional gauge of contaminant buildup (proposals 5561 and 5655); frequent dark images to monitor dark current stability, to identify variable hot pixels, and to produce dark frames for pipeline calibration (proposal 5562); high-illumination internal flats to establish the pixel-to-pixel sensitivity variations (proposals 5569 and 5764). In addition, regular decontaminations were carried out each month (proposal 5568), and internal images (INTFLATS, darks, K-spots) were taken at that time.

Other proposals carried out in Cycle 4 include: systematic observations of the bright Earth to determine the telescope transmission pattern, for use in generating high quality flat fields (proposals 5570 and 5571); determination of the vignetting function and the throughput of partially rotated filters through observations of the standard calibration star and internal flat fields (proposal 5643); aperture determination and wavelength calibration of the linear ramp filters (6140); aperture and polarimetry calibration of the polarizers via observation of a variety of external sources (proposal 5574); and verification of Lyman alpha throughput, especially in order to provide a starting point for future monitoring (proposal 5778).

The proposals are briefly listed below; Section 2 summarizes their status, Section 3 provides more detail about the purpose and result of each proposal, and Section 4 lists all documentation produced during Cycle 4. All images from these proposals are public and retrievable from the archive via STARVIEW. All calibration reference files generated from the calibration data are also available from the archive; for comprehensive lists of filenames, please refer to the memos maintained on WWW WFPC2 Documentation page: the Reference File Memo (files used in the pipeline) and the Alternate Reference File Memo (files not used in the pipeline but alternates available for calibration).
2. Summary of Results

A summary of the calibration programs executed during Cycle 4 is given in Table 1. Listed for each proposal is an informal title and brief description, proposal number (ID), products generated, other comments and/or products, and status of the proposal based on an estimate of amount of work remaining to complete the products. The following section of this report provides more detail, in the form of one-page summaries for each proposal.

The success of the WFPC2 Cycle 4 calibration was, of course, due to the efforts of many people: the STScI WFPC2 group members, past and present -


as well as the WFPC2 IDT members -

Gilda Ballester, John Clarke, David Crisp, Robin Evans, John Gallagher, Richard Griffiths, J. Jeff Hester, John Hoessel, Jon Holtzman, Jeremy Mould, Paul Scowen, Karl Stapelfeldt, John Trauger, Alan Watson, and James Westphal
Table 1. WF/PC 2 Cycle 4 Calibration Program Status Report

<table>
<thead>
<tr>
<th>proposal and description</th>
<th>prop ID</th>
<th>products</th>
<th>other</th>
<th>status</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PHOTOMETRY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mon1: pc1,wf3 (9 filters) with grw+70d5824</td>
<td>5563</td>
<td>C CW DH IH H M W</td>
<td>focus monitoring</td>
<td>done</td>
</tr>
<tr>
<td>Mon2 : Omega Cen, 5 filters</td>
<td>5565/</td>
<td>C CW DH IH H - W</td>
<td>done</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5663</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mon3: 4-chip F170W with grw+70d5824</td>
<td>5629</td>
<td>C CW DH IH H M W</td>
<td>done</td>
<td></td>
</tr>
<tr>
<td>Phot. Calib: grw+70d5824, 4 chips (5 filters)</td>
<td>5564</td>
<td>(C) - - - - - -</td>
<td>ISR planned</td>
<td>80%</td>
</tr>
<tr>
<td>Filter Calib: filter sweep with std star and field</td>
<td>5572</td>
<td>C CW DH IH H - W</td>
<td>ISR to be issued soon</td>
<td>done</td>
</tr>
<tr>
<td>Dither -- CTE with Omega Cen field</td>
<td>5646/</td>
<td>- - - - H - -</td>
<td>low S/N; still under investigation</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td>5659</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>INTERNALS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intmon1: intflats, biases, kspots</td>
<td>5560</td>
<td>(C) - - - H M W</td>
<td>ISR planned</td>
<td>90%</td>
</tr>
<tr>
<td>Intmon2: visflats, uvflats, 2 darks (clocks on)</td>
<td>5561/</td>
<td>C - - - - M -</td>
<td>done</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5655</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intmon3: weekly darks</td>
<td>5562</td>
<td>C CW DH IH H M W</td>
<td>hot pixel lists; ISR planned</td>
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<tr>
<td>Flats: intflats, visflats (range of filters)</td>
<td>5569/</td>
<td>C - DH - - M -</td>
<td>pinhole identification</td>
<td>done</td>
</tr>
<tr>
<td></td>
<td>5764</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>OTHER</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decon: internals + decon</td>
<td>5568</td>
<td>C CW - IH - M W</td>
<td>done</td>
<td></td>
</tr>
<tr>
<td>Earthflats (200 in 4 NB; 20 each in 19 filters)</td>
<td>5570/71</td>
<td>(C) CW - - - - -</td>
<td>ISR planned</td>
<td>80%</td>
</tr>
<tr>
<td>Partially Rotated Filters: std star and visflats</td>
<td>5643</td>
<td>- - DH IH - - -</td>
<td>database update</td>
<td>done</td>
</tr>
<tr>
<td>Preflash Test: Omega Cen field</td>
<td>5632</td>
<td>- - - - - - -</td>
<td>preflash too short</td>
<td>failed</td>
</tr>
<tr>
<td>Lyman Alpha: throughput check (std star)</td>
<td>5778</td>
<td>- - - - - - -</td>
<td>for Failure Review Board</td>
<td>90%</td>
</tr>
<tr>
<td>(WF/PC1 pickoff mirror)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ramps: internals</td>
<td>6140</td>
<td>- CW DH IH - - W</td>
<td>database update</td>
<td>90%</td>
</tr>
<tr>
<td>Polarization: standard stars and fields, all chips</td>
<td>5574</td>
<td>(C) - DH IH - W</td>
<td>ISR completed.</td>
<td>80%</td>
</tr>
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</table>

a. Notes: C=CDBS files (including synphot tables),
CW=Calibration Workshop,
DH = Data Handbook,
IH=WFPC2 Instrument Handbook,
H = Holtzman PASP papers
M = Monitoring
W = WWW postings
ISR = Instrument Science Report
Items in () are in the process of being completed.
3. Individual Proposals

A one-page summary for each proposal is presented in this section. The summary includes a statement of the general purpose of the proposal, followed by a more detailed description of the observations performed. Any products generated from the proposal’s data are listed, as well as estimates of the intended accuracy and actual accuracy achieved. For illustration, occasional tables and figures are included with some of the proposals. Finally, to round out the summaries, a brief statement of any continuation (Cycle 5) plans for each proposal is also provided.
PHOTOMETRIC CAL MONITOR 1: UV/OPT STD (5563)

Purpose: Monitor the photometric stability and quantum efficiency of WFPC2 from the FUV to near-IR.

Description:
A UV spectrophotometric standard star (GRW+70D5824) was observed with PC1 and WF3, clocks off, using the photometric filters (F336W, F439W, F555W, F675W and F814W), and UV filters (F160BW, F170W, F218W and F255W). The initial intent was to execute the proposal once every four weeks although after SMOV results highlighted the need for monthly decontamination procedures (decons), the proposal was expanded to run before and after each decon. The primary target of choice was GRW+70D5824; if it was not visible, Feige 110 was used instead. After pipeline processing and cosmic ray removal, each image was reduced via aperture photometry to determine the throughput.

Products:
The data was closely monitored each month, and results were regularly posted on WWW (tables of countrates as well as figures), included in the Instrument and Data Handbooks, used in the IDT PASP papers (Holtzman et al. 1995), incorporated into OPUS pipeline via updates to the synphot tables, and presented at meetings (weekly, monthly, calibration workshop). The measurements allowed tracking of the contaminant buildup (see Fig. 1) so that informed decisions could be made regarding the frequency and type of decontamination procedures required. In addition, the observations were used to monitor focus (see Fig. 2), support GO/GTO science observations requiring broadband photometric calibration, update synphot tables, and monitor the Wood’s filter stability.

Accuracy Expected:
Intent is to measure the monthly variations, not expected to be more than 1-2%.

Accuracy Achieved:
Scatter from month to month was on the order of ~2% (e.g., 2% in F555W, ~1.5% in F675W and F814W, and worst in the UV, e.g., ~3.5% in F170W).

Continuation Plans:
Standard star monitoring is being continued with the Cycle 5 Photometric Monitor proposal, at a reduced level: only 1 chip per month instead of 2; a different chip is planned for each month.
Figure 1: Monitoring results from proposal 5563; decontamination (decon) dates are marked with dashed lines. Solid line is cooldown date (Apr 23, 1994). Photometry was done using 0.5" radius aperture; countrates were normalized to the June 14, 1994 (1 day after decon) countrate. Data taken in Dec 1994 were taken with clocks on and are not included here.
Figure 2: Focus position measured using the phase retrieval method on PC images of GRW+70D5824, both in F439W (filled squares) and in F814W (open circles), over the period March-December 1994. Day numbers start at January 1, 1994. The vertical line represents Day 180 (June 29), when the secondary mirror was moved by 5µ. The other lines are best-fit linear relations for the focus position in F439W (dashed) and F814W (dotted), with the change at Day 180 constrained to be 5µ. The slopes of the two lines represent a rate of change in the focus position of -0.75 and -0.92 µ/month for F439W and F814W, respectively.
**PHOTOMETRIC CAL MONITOR: FIELDS (5565/5663)**

**Purpose:**

Calibrate the color terms of the photometric filter set, and build a database of observations suitable for the study of instrument dependent variables in the calibration of high precision photometric observations. Monitor the astrometric stability of the instrument, map the geometric distortions across the field of view and monitor the optical stability across the field of view in each CCD.

**Description:**

This proposal obtained images of an HST Calibration field through the photometric filter set (F336W, F439W, F555W, F675W and F814W). The initial intent was to execute the proposal once every four weeks although after SMOV results highlighted the need for monthly decontamination procedures (decons), the proposal was expanded to run before and after each decon.

**Products:**

Results of the photometric data analysis were presented in the Holtzman et al. PASP papers, the Data and Instrument Handbooks, the Calibration Workshop, and in the photometry memos on the WWW. Distortion coefficients were computed and implemented in the STSDAS wmosaic code; an Instrument Science Report was written and posted to WWW.

**Accuracy Expected:**

Transformations were expected to be accurate to ~2-3%.

**Accuracy Achieved:**

Photometric accuracies of 5-10% are easily achievable; better results (2-3%) are possible with a few corrections. Some of the limiting factors have been found to be: the CTE problem, contamination effects (primarily UV), and flatfield accuracies. The plate scales have been determined to +/- 0.0001; relative accuracy of astrometry achievable with WFPC2 is ~4-10 mas (absolute accuracy is limited by guidestar accuracies, generally ~1").

**Continuation Plans:**

Field monitoring was not continued into Cycle 5, although other calibration proposals will be using standard fields like Omega Cen (e.g., CTE calibration, flatfield check, etc).
**PHOTOMETRIC CAL MONITOR: 4-CHIP STD in F170W (5629)**

**Purpose:**
Monitor the UV QE once a week in 1 filter in each of the 4 cameras.

**Description:**
Observations of the UV spectrophotometric standard GRW+70D5824) in each camera were obtained using F170W. Monitoring was done more frequently than the larger Photometric Monitoring proposal (5563), once per week instead of twice per month. To minimize observing time, single CCD readout was used for the initial PC1 observation to establish pointing; the WF observations that followed were done using gyros, reading out only after all three WF images were taken.

**Products:**
The data was closely monitored each week, and results were regularly posted on WWW (tables of countrates as well as figures), included in the Instrument and Data Handbooks, used in the IDT PASP papers (Holtzman et al. 1995), incorporated into OPUS pipeline via updates to the synphot tables, and presented at meetings (weekly, monthly, calibration workshop).

The weekly measurements allowed tracking the contaminant buildup in all 4 chips, so that informed decisions could be made regarding the frequency and type of decontamination procedures required. In addition to the contamination monitoring, the observations were used to support GO and GTO science observations requiring broadband photometric calibration, to update synphot tables, and to monitor the Wood’s filter (F160BW) stability.

The F170W monitoring results for each chip are included here in Figure 3; an electronic copy of this plot as well as tabulated countrates and dates are available on WWW.

**Accuracy Expected:**
The intent is to measure the monthly variations, not expected to be more than 2%.

**Accuracy Achieved:**
Scatter is about 5%, some of which is likely to be due to contamination (the observations taken can vary in phase by several days).

**Continuation Plans:**
Monitoring in F170W is being continued in Cycle 5.
Figure 3: F170W monitoring results for each camera; decontamination (decon) dates are marked with dashed lines. Photometry was done using 0.5” radius aperture; countrates were normalized to the April 24, 1994 (1 day after decon) countrate. Although there is quite a bit of scatter between the post-decon observations (most likely due to contamination: post-decon measurements can be taken anytime from 1 day to 7 days after a decon), the decons appear to be successfully removing the contamination layer.
**PHOTOMETRIC CALIBRATION 2: 4 CCD (5564)**

**Purpose:**
Establish the relative CCD to CCD sensitivities for the photometric filter set, in order to apply results of the Photometric Monitor 1 and Photometric Filter Calibration to all four chips.

**Description:**
This proposal ran once; images of the standard star GRW+70D5824 were taken with PC1, WF2, WF3 and WF4 through the photometric filter set (F336W, F439W, F555W, F675W and F814W).

**Products:**
Used as check for synphot table updates. Results are being written up in an Instrument Science Report, to be available soon.

**Accuracy Expected:**
Absolute photometry is expected to be accurate to ~2%; chip to chip relative photometry should be accurate to ~1%.

**Accuracy Achieved:**
Relative photometric accuracy is better than 1%; work is in progress.

**Continuation Plans:**
This proposal was not continued into Cycle 5 although the Cycle 5 standard star photometric monitor will obtain, over the year, data on all 4 cameras through the photometric filter set.
PHOTOMETRIC FILTER CALIBRATION (5572)

Purpose:
Provide photometric calibration for medium and narrowband filters.

Description:
The photometric filter calibration proposal consisted of imaging a UV spectrophotometric standard (grw+70d5824), in PC1 and WF3, through all the filters used by GO/GTOs during cycle 4 (F380W, F390N, F410M, F437N, F450W, F467M, F469N, F487N, F547M, F569W, F502N, F656N, F673N, F588N, F606W, F622W, F631N, F658N, F702W, F785LP, F791W, F850LP, F953N, F1042M and fquv*, fqch4*). Omega Cen was also observed with a subset of heavily requested (e.g., parallel) broadband filters (F300W, F547M, F569W, F606W, F702W, and F785LP; standard broadband filter set was used in monthly monitor 5565/5663). The standard star and field observations were performed twice during Cycle 4.

Products:
The results from this data were used to update the synphot tables. These tables have three primary uses: 1) to provide photometric calibration information, which is inserted by the pipeline calibration software into image headers: (keywords photflam, photbw, etc) 2) to estimate exposure times for HST observations and 3) to use synthetic photometry to calibrate observations. Included here in Figure 4 are the new values of photflam and zeropoints. Results from this proposal were also presented in the WFPC2 IDT PASP papers, as well as in the Instrument and Data Handbooks, the Photometry memos on WWW, and the May 1995 Calibration Workshop. An Instrument Science Report is in preparation.

Accuracy Expected:
Absolute photometry is expected to be accurate to ~2%; chip to chip relative photometry should be accurate to ~1%.

Accuracy Achieved:
Relative photometric accuracy is better than 1%; work is in progress.

Continuation Plans:
A photometric zeropoint proposal is planned for Cycle 5.
Figure 4: Table of new PHOTFLAMs and zeropoints. The pre-launch synphot tables were updated based on the filter calibration data; typical changes were +15% to -5% in the visible and infrared while more drastic changes were required for F160BW (+44%) and F170W (-18%). The “Photometry with WFPC2” (May 1995 Calibration Workshop proceedings, also on WWW) and the WFPC2 IDT PASP papers provide more details on photometry with WFPC2, including various small corrections that can be applied to the data.

<table>
<thead>
<tr>
<th>Filter</th>
<th>PHOTFLAM (Old)</th>
<th>PHOTFLAM (New)</th>
<th>ZP (STMA)</th>
<th>ZP (Vega)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F170W</td>
<td>1.789 E-15</td>
<td>1.471 E-15</td>
<td>15.981</td>
<td>16.287</td>
</tr>
<tr>
<td>F258W</td>
<td>5.210 E-16</td>
<td>5.308 E-16</td>
<td>17.088</td>
<td>16.985</td>
</tr>
<tr>
<td>F336W</td>
<td>5.737 E-17</td>
<td>5.675 E-17</td>
<td>19.515</td>
<td>19.399</td>
</tr>
<tr>
<td>F380W</td>
<td>2.387 E-17</td>
<td>2.547 E-17</td>
<td>20.400</td>
<td>20.962</td>
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<tr>
<td>F390N</td>
<td>6.419 E-16</td>
<td>6.489 E-16</td>
<td>16.871</td>
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</tr>
<tr>
<td>F410M</td>
<td>9.122 E-17</td>
<td>1.022 E-16</td>
<td>18.876</td>
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</tr>
<tr>
<td>F437N</td>
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<td>8.136 E-18</td>
<td>8.863 E-18</td>
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<td>F467M</td>
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<td>F555W</td>
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<td>F569W</td>
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<td>F814W</td>
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<td>16.076</td>
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<td>F1042M</td>
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</table>

NOTES:
1. Values are for WF3 using the gain=7 setup. For the other chips multiply PHOTFLAM by 0.9905 (PC1), 0.9985 (WF2), and 0.9746 (WF4), or add -0.010 (PC1), -0.002 (WF2), -0.028 (WF4) to the zeropoints, as derived from Table 5 below. You can also use the IMHEADER command to retrieve PHOTFLAM for each chip, or to determine PHOTFLAM for the gain=14 setup.
CTE DITHER TEST (5646, 5659)

Purpose:
Quantify the CTE effect.

Description:
Previous photometric analysis of the Omega Cen field revealed an apparent 4% ramp across each CCD in the direction of the columns (parallel register). Flatfielding does not remove the effect nor does it appear to be intrinsic to the flatfields; it is also seen in cosmic ray analysis of long dark frames. To quantify the effect in an efficient manner, this proposal obtained five images (each offset slightly from the previous one) of the Omega Cen photometric field along the WFPC2 X direction and four images along the Y direction, again each image offset somewhat from the previous ones. The pointings, specified with postargs, were arranged to ensure the maximum starfield overlap. The F555W filter is used along with the exposure times from the IDT's SMOV dither test, which will facilitate direct comparisons with the earlier data (proposal 5646) and the F439W and F814W filters were used (proposal 5659) to obtain information on the CTE effect's wavelength dependence.

Products:
Ramp effect identified and quantified by Holtzman et al. (PASP 106,156). The data from this proposal is also being used in conjunction with Cycle 5 CTE program.

Accuracy Expected:
The intent was to test for CTE effects on photometry; the ramp is expected to be defined to 1-2%.

Accuracy Achieved:
The CTE effect is a 3-4% ramp, peak to peak, to within 1-2%. Additional work is in progress.

Continuation Plans:
Further tests are being carried out in Cycle 5 to determine how the ramp changes with observing conditions.
INTERNAL MONITOR.1 (5560)

**Purpose:**
Monitor the short term health and stability of the WFPC2’s cameras.

**Description:**
This proposal was the routine internal monitor run twice weekly during Cycle 4. Each execution included two bias frames at each gain setting, two INTFLATS with the F555W filter through each bay, and two Kelsall spot images with exposure times optimized for the WF and PC, respectively. The data tested the integrity of the CCD camera chain electronics in both bays (7 e/DN and 15 e/DN). The pairs of INTFLATs would also provide a test for quantum efficiency hysteresis in the CCDs and an internal check on the alignment of the WFPC2 optical chain.

**Products:**
The bias frames were used to generate biasfiles for use in the OPUS pipeline; an ISR is in progress. The data was also used to monitor for possible buildup of contaminants on the CCD windows (worms).

**Accuracy Expected:**
Intent is to use 40 bias observations make each reference file for the pipeline; accuracy is expected to be ~0.8 electrons/pixel.

**Accuracy Achieved:**
Work is in progress

**Continuation Plans:**
Internal monitoring is continued at the same level throughout Cycle 5.
INTERNAL MONITOR.2 - FLATS (5561/5655)

**Purpose**: Monitor the internal flatfields of the instrument, including 1) the flat field repeatability with time through the main photometric filter set and use to generate a database of high signal to noise flat fields. 2) the stability of the cal-channel tungsten lamps by comparing INTFLAT to VISFLAT flat fields in the same filter. 3) the UV throughput and the buildup of contaminants on the CCD windows (and use flats to generate higher signal to noise flat fields for UV observations since the flux from individual UV flats is relatively low)). 4) the stability of the UV lamp (tie the UV flats to the VISFLATs). 5) the Woods filter throughput and red leak. Note: this proposal takes VIS-and UVFLATs; INTFLATs are obtained in other proposals (5560, 5568, and 5569/5574).

**Description**: Flatfields were obtained with the photometric filter set (F336W, F439W, F555W, F675W and F814W), using the visible cal-channel lamp (VISFLAT). UV flat fields were obtained with the cal-channel's ultraviolet lamp (UVFLAT) using the UV filter set (F170W, F160BW and F336W). The VISFLAT/UVFLAT ratio from the F336W flat fields provided a diagnostic of the UV flat field stability. A VISFLAT exposure with the Woods' filter (F160BW) allowed its visible transmission and redleak to be monitored (using F170W as a control). Two VISFLAT exposures obtained through the LRF (FR533N), one at each gain can be used to generate histograms and trace the ADC transfer curve. Two supplemental dark frames are obtained with clocks=on for the purpose of calibrating science frames and monitoring the dark current rate for this mode of operation.

**Products**: VIS and UV lamp throughputs are regularly monitored (see Figures 5 and 6, respectively). Based on the dramatic decline in UV lamp throughput, the UV lamp usage was reduced in 1994; the VISFLATs may be reduced in 1996. The VISFLATs are also being compared to previous and current data, to verify that none of the filters are developing problems; an ISR is in progress. A greyscale VISFLAT image is included here as Figure 7.

**Accuracy Expected**: The VISFLATs, when well exposed, are each accurate to < 1% in terms of the high frequency variations in the CCD, thereby providing a check of the flat-field stability to 1%. Combining results from several filters provides an even better check of the stability (<1%).

**Accuracy Achieved**: The VISFLAT repeatability is quite good, any problems down to the ~0.5% level would have been detected.

**Continuation Plans**: Internal monitoring is continued during Cycle 5 at the same level for the VIS lamp and at a reduced level for the UV lamp (run twice only). Since the VISFLATs are stable pixel-to-pixel, the VISFLAT monitoring may eventually be reduced.
Figure 5: F555W VISFLAT ratios from Apr 28, 1994 (MJD=49470) to Nov 19, 1995 (MJD=50050). VISFLAT countrates, based on all good pixels, are normalized to the June 15, 1994 observation (2 days after decon); decons are marked with dashed vertical lines. The first 6-8 data points in each camera are skewed due to higher numbers of saturated pixels; at that time, slightly longer exposure times were in use, resulting in 3-30% of the pixels saturating (PC1 and WF4 were the least saturated, WF3 the most). The expected decline before, and recovery after, each decon is readily apparent; there is also a gradual decline in the VIS lamp throughput. The jump around Aug 31, 1995 (MJD=49960) is attributed to higher-than-normal VIS lamp usage: VISFLATs in all filters not regularly monitored were taken within a few weeks of each other; the rate after the jump returns to approximately the same rate as before the jump. Since the VISFLATs are quite stable from pixel to pixel, the monitoring will likely be reduced in future cycles and/or the filter sweep VISFLATs may be spread out over the entire cycle, in order to preserve the lamp.
Figure 6: UVFLAT ratios from Feb 14, 1994 to Aug 29, 1995. UVFLAT countrates from the central 400x400 pixels are normalized to the April 28, 1994 observations (4 days after decon); decons are marked with dashed vertical lines. The expected decline before, and recovery after, each decon is apparent, as well as a steep, overall decline in the UV lamp throughput during the first few months of use. For this reason, frequent regular use of the UV lamp was discontinued in 1994; the lamp is monitored only once or twice during the year; the last two measurements were taken Oct 1994 and Aug 1995. To decrease usage even further, the F255W UVFLATs were not taken in 1995.
**Figure 7:** Ratio of F439W internal VISFLATs taken before and after a decontamination for CCD WF2. The image taken before the decontamination has linear regions (worms) where the counts are about 1% larger (darker in this display) than the surrounding regions.
INTERNAL MONITOR 3: DAKS (5562)

**Purpose:** Monitor the dark current rate and CCD hot pixels.

**Description:** Twenty dark frames, 1800 sec each, were taken every month. Note: these were clocks=off darks; the clocks=on darks were taken with Internal Monitor 2 (5561/ 5655).

**Products:**

Dark frames were used to generate pipeline dark reference files, 10 frames per file; in addition, “superdarks” (100 darks), although not used in the routine pipeline, were generated by the WFPC2 IDT and STScI. Both types of files are accessible to observers via the archive. A Reference File Memo and an Alternate Reference File Memo on WWW were regularly updated to reflect the new files. Hot pixel lists were generated with a 1-week time resolution and regularly posted on WWW as well; an extract of the first page from one of these lists is included here in Figure 8. Results from this proposal have been presented in the WFPC2 IDT PASP papers, in the Instrument and Data Handbooks, and at the May 1995 Calibration Workshop. An Instrument Science Report is being prepared.

**Accuracy Expected:**

Assuming the pipeline reference files are generated from 10 input darks, the expected accuracy is ~1.6 electrons per pixel.

**Accuracy Achieved:**

The residual systematic error (1800 sec exposure), after dark subtraction using a Cycle 4 pipeline file, is estimated at 3 electrons, less than the readnoise in a single frame. Observers with multiple orbits of exposures may wish to recalibrate with the alternate superdarks instead of the pipeline darks; please see the 1995 Data Handbook for details. In addition, the dark frames were found to possess a “glow” or a characteristic edge drop of about 50%, varying by about 30% (peak-to-peak) in each CCD; its amplitude appears to correlate well with the cosmic ray activity. The glow is not a problem for the vast majority of observations, but please refer to the 1995 Data Handbook for more details about the glow as well as the pipeline darks, superdarks, and hotpixel corrections.

**Continuation Plans:**

Monitoring is being done at the same level in Cycle 5 (5 per week); to minimize the effects of new hot pixels, darks are constrained to be taken within a 2-day period. Currently under investigation is the level of improvement achievable in pipeline-processed science images by using a “superdark” instead of the current pipeline darks.
**Figure 8:** Single page excerpt from one of the WWW hotpixel list (951016_951113). These tables can now be used with the STSDAS task “warmpix” to flag and/or correct hot pixels in WFPC2 images.
INTERNAL FLATS (5569/5764)

Purpose:
Calibrate the pixel to pixel non-uniformity of the WFPC2 CCDs.

Description:
This proposal is designed to take internal flats using the cal-channel visible lamp (VIS-FLATs) and the internal source (INTFLATs) as the illumination source. The WFPC2 cal-channel source will be used to obtain flat fields for most of the visible (i.e. F336W - F1042M) WFPC2 filters in order to map the pixel to pixel non-uniformity of the CCD detectors. These flats will be used together with SLTV flat fields and streakflats (exposures of the bright earth) to generate 'superflats' which will correct for the instrumental signature. INTFLATS using WFPC2's internal lamp are also obtained in the same epoch to provide a baseline comparison of INTFLAT vs VISFLAT, in the event of a cal-channel system failure. VISFLAT frames were grouped into ~40 minute stacks to minimize use of the cal-channel lamp system. There were two INTFLAT sequences; one set done on shutter blade A, the other set on shutter blade B, due to differences in the shutterblade reflectivities.

Products:
These files are primarily used for monitoring and pinhole identification; an Instrument Science Report is being prepared. The VISFLATs may be used in the future to generate deltaflats, a correction for any time-variable flatfield patterns.

Accuracy Expected:
The S/N per pixel for the VISFLATs should be ~1%; the INTFLATs are intended as a backup for the cal-channel VISFLATs. The data should provide a good estimate of the gain ratios and their stability.

Accuracy Achieved:
The VISFLAT repeatability is quite good, any problems to the ~0.5% level would have been detectable. The INTFLATs will not be used unless the cal-channel fails.

Continuation Plans:
The INTFLAT and VISFLAT monitoring is being continued in Cycle 5.
DECONTAMINATION (5568)

**Purpose:** Define the decontamination (decon) procedure to be used during Cycle 4.

**Description:**
A set of internal observations were taken both before and after each decon. The set of internals consisted of: two F555W intflats at gain 7, two F555W intflats at gain 15, 2 kspots (a 1 sec and a 2.6 sec exposure) and 5 darks (clocks off). The WFPC2 operating temperature was lowered in April 1994 from -76C to -88C after SMOV data showed that there was a 10-15% ramp in CTE (stars measured at higher row numbers are systematically fainter). The colder operating temperature reduces the CTE problem to a 4-5% effect but results in contaminant buildup on the CCD windows. Although decons were initially planned to execute twice per year, more frequent decons (1/month) were necessary to counteract the higher rate of contamination buildup - and associated faster decline in the UV throughput - encountered when operating the CCDs at a lower-than-intended temperature (-88C).

**Products:**
Internal flats were used to verify that each decon was successful in removing the window contaminants. Kspot images were in place to check that the optical alignment was maintained throughout the thermal cycling. Darks were used to monitor hot pixel annealing and used with data from the Internal Monitor - Darks (5562) to generate dark calibration files for the pipeline. Both long and short decons (12 and 6 hours) were performed, to check for possible gains with the longer warm period (list of decon dates is given in Table 2 and is maintained in the WWW WFPC2 History memo). However, the number of hot pixels annealed was the same for long and short decons, so the shorter time has been has been used since late 1994.

**Accuracy Expected:**
Decons are used to remove the UV blocking contaminants from the CCD window; the internal images before and after each decon will verify the success of the procedure.

**Accuracy Achieved:**
Contaminants were successfully removed with decons from this proposal; annealed hot pixels were identified. (see also proposal 5562, Dark Monitor).

**Continuation Plans:**
A copy of this proposal was continued into Cycle 5 (with the addition of 2 biases in the set of internal observations done before and after each decon).
Table 2. List of Decontamination Dates. Time given reflects the start time of cooldown; chips are cold and ready for science about 3.5 hours later. Decon and warmup of chips start ~10 hrs prior to time listed.

<table>
<thead>
<tr>
<th>year</th>
<th>UT date</th>
<th>day of year</th>
<th>MJD</th>
<th>type of decon</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>22 Feb 11:37</td>
<td>053</td>
<td>49405.4840</td>
<td>6 hour decon</td>
</tr>
<tr>
<td></td>
<td>24 Mar 11:08</td>
<td>083</td>
<td>49435.4639</td>
<td>6 hour decon</td>
</tr>
<tr>
<td></td>
<td>24 Apr 00:49</td>
<td>114</td>
<td>49466.0340</td>
<td>6 hour decon; temp reduced from -76C to -88C</td>
</tr>
<tr>
<td></td>
<td>23 May 15:00</td>
<td>143</td>
<td>49495.6250</td>
<td>5.5 hour realtime contingency decon used</td>
</tr>
<tr>
<td></td>
<td>13 Jun 11:02</td>
<td>164</td>
<td>49516.4597</td>
<td>12 hour decon</td>
</tr>
<tr>
<td></td>
<td>10 Jul 11:40</td>
<td>191</td>
<td>49543.4861</td>
<td>12 hour decon</td>
</tr>
<tr>
<td></td>
<td>28 Jul 07:12</td>
<td>209</td>
<td>49561.3000</td>
<td>12 hour decon</td>
</tr>
<tr>
<td></td>
<td>27 Aug 09:46</td>
<td>239</td>
<td>49591.4069</td>
<td>12 hour decon</td>
</tr>
<tr>
<td></td>
<td>25 Sep 00:46</td>
<td>268</td>
<td>49620.0319</td>
<td>12 hour decon</td>
</tr>
<tr>
<td></td>
<td>21 Oct 00:41</td>
<td>294</td>
<td>49646.0285</td>
<td>12 hour decon</td>
</tr>
<tr>
<td></td>
<td>19 Nov 17:29</td>
<td>323</td>
<td>49675.7285</td>
<td>6 hour decon</td>
</tr>
<tr>
<td></td>
<td>18 Dec 06:00</td>
<td>352</td>
<td>49704.2500</td>
<td>6 hour decon</td>
</tr>
<tr>
<td>1995</td>
<td>13 Jan 16:14</td>
<td>013</td>
<td>49730.6764</td>
<td>6 hour decon</td>
</tr>
<tr>
<td></td>
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<td>043</td>
<td>49760.0792</td>
<td>6 hour decon</td>
</tr>
<tr>
<td></td>
<td>11 Mar 14:30</td>
<td>070</td>
<td>49787.6042</td>
<td>6 hour decon</td>
</tr>
<tr>
<td></td>
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<td>49815.4368</td>
<td>6 hour decon</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
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<td>6 hour decon</td>
</tr>
<tr>
<td></td>
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<td>49895.8333</td>
<td>6 hour decon</td>
</tr>
<tr>
<td></td>
<td>30 Jul 08:50</td>
<td>211</td>
<td>49928.3681</td>
<td>6 hour decon</td>
</tr>
<tr>
<td></td>
<td>27 Aug 05:43</td>
<td>239</td>
<td>49956.2382</td>
<td>6 hour decon</td>
</tr>
<tr>
<td></td>
<td>22 Sep 03:40</td>
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<td>49982.1528</td>
<td>6 hour decon</td>
</tr>
<tr>
<td></td>
<td>17 Oct 09:43</td>
<td>290</td>
<td>50007.4053</td>
<td>6 hour decon</td>
</tr>
<tr>
<td></td>
<td>15 Nov 08:53</td>
<td>319</td>
<td>50036.3706</td>
<td>6 hour decon</td>
</tr>
<tr>
<td></td>
<td>14 Dec 07:03</td>
<td>348</td>
<td>50065.2929</td>
<td>6 hour decon</td>
</tr>
</tbody>
</table>
EARTHFLATS (5570,5571)

Purpose: Provide data for the construction of WFPC2 flat fields necessary for the calibration of Cycle 4 GO/GTO science.

Description:

The first proposal obtained 200 streakflats - exposures of the bright earth - in each of the 4 filters listed in the table below, in order to generate high quality narrow-band flat fields (narrow filters were used since broadband streakflats saturate unless used in conjunction with neutral density filters). The resulting "earth superflats" map the OTA illumination pattern and are combined with TV (thermal vacuum test) data and cal-channel flat fields for the WFPC2 filter set to generate a set of superflats capable of removing both the OTA illumination and pixel-to-pixel response of the camera from science images. The second proposal obtained 20 streakflats per filter (see Table below); these moderate signal streakflats are used to assess the superflats generated from proposal 5570 and provide small updates to the superflats to correct for filter dependent effects.

<table>
<thead>
<tr>
<th>Filters used for Earthflats</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 each of: F375N F502N F656N F953N</td>
</tr>
<tr>
<td>20 each of: F160BW F218W F255W F300W F336W F380W F390N</td>
</tr>
<tr>
<td>F437N F469N F487N F631N F658N F673N</td>
</tr>
<tr>
<td>F122M + F122M + F122M + F122M + F122M + F122M +</td>
</tr>
<tr>
<td>F437N F487N F658N F439W F555W F675W</td>
</tr>
</tbody>
</table>

Products: Flatfield files are being generated for the OPUS pipeline; files are nearly complete and will be installed into the pipeline in the near future.

Accuracy Expected:

The flatfields were expected to have 0.5-1.0% pixel to pixel, and 1-2% large scale, accuracies.

Accuracy Achieved:

The IDT flatfields, in use in the pipeline during Cycle 4, had essentially the expected errors (~2%; worse at the edges: 3-5%). The new pipeline flatfields, to be installed late 1995, will provide similar quality flats plus improvements at the edges: comparisons with sky flats generated by the Medium Deep Survey team indicate that the errors are < 1%.

Continuation Plans:

A similar 2-part program for streakflats is being run in Cycle 5.
**PARTIALLY ROTATED FILTERS (5643)**

**Purpose:**
Update the aperture database and provide calibration for Cycle 4 GO/GTO science.

**Description:**
The UV spectrophotometric standard GRW+70D5824 was observed through the partially rotated filter set (methane quads and redshifted [OII] filter). In addition, internal flats with the partially rotated filters were taken with the cal-channel visible lamp. The sequence of observations was performed twice during the Cycle.

**Products:**
The data was used to verify and update the apertures to their optimum location as well as locate the unvignetted field of view. In addition, the flats are being used to determine the pixel to pixel non-uniformity of the CCD detectors and, together with the SLTV flatfields and earthflats, will be used to generate "superflats" which will correct for the instrumental signature. Results have been presented in the Instrument and Data Handbooks; in addition, an Instrument Science Report is being prepared.

**Accuracy Expected:**
The intent is to locate the optimum apertures to within +/- 1” while photometric accuracies are expected to be ~2%.

**Accuracy Achieved:**
Apertures were located to ~0.5”; work on the photometric calibration is in progress.

**Continuation Plans:**
Programs to improve the calibration of these filters are planned for Cycle 5.
**PREFLASH TEST (5632)**

*Purpose:*
Investigate the impact of preflash on the CTE effect.

*Description:*
Analysis of Omega Cen calibration fields has revealed what appears to be a variation of ~4% across each CCD in the direction of the columns (parallel register). On the basis of analysis done by the WFPC2 Science Team and STScI we have established the following facts: 1) A variation of ~4% is seen in Omega Cen images across each chip in the direction of the columns (parallel register). 2) This effect is not removed by flat fielding, nor, does it appear to be intrinsic to the flat fields themselves. 3) It is also seen in analysis of cosmic ray events in long dark frames. 4) Pre-assembly engineering data does not appear to show the effect (John Trauger). This proposal was intended to check whether preflashing would diminish the CTE effect.

To prevent adding extra calibration observing time, this proposal replaced one of the normal monthly Omega Cen observation sets (5565/5663). For the preflash test, two different preflash levels were planned for both the F439W and F675W images. The remaining exposures in the Omega Cen set (F336W,F555W,F814W) were not preflashed.

*Products:*
Results from this proposal provided better estimates of the required preflash times.

*Accuracy Expected:*
Preflash was expected to reduce the CTE effect.

*Accuracy Achieved:*
The preflash times used were too short but helped define more appropriate times and other tests to perform in the Cycle 5 CTE proposal.

*Continuation Plans:*
Tests to investigate the CTE problem as well as possible scheduling/implementation solutions are continued in Cycle 5.
LYMAN ALPHA THROUGHPUT VERIFICATION (5778)

Purpose:
Verify that the Lyman alpha filter throughput has not degraded since Jan 94.

Description:
A UV spectrophotometric standard star (BD+75D325) was observed with PC1 and WF3 using F122M alone and in conjunction with the F130LP, providing a measure of the throughput as well as redleak. These data were used in conjunction with F122M observations obtained during Spring 1994 (SMOV proposal #4763). The primary intent was to check that there had been no decline in WFPC’s pickoff mirror (POM) comparable to that experienced by WF/PC-1 during it first year in orbit.

Products:
Analysis of data from this proposal provided information for the Failure Review Board meetings concerning the WF/PC1 pickoff mirror degradation found after WF/PC1 was returned to the ground. An Instrument Science Report has been drafted and will be posted to the WWW in the near future.

Accuracy Expected:
The detection of a clear signal at 122 nm would be sufficient to deduce that the surface of the POM has not been significantly degraded since the installation of the flight mirror at JSC.

Accuracy Achieved:
The F122M throughput was measurable to ~20%.

Continuation Plans:
Yearly monitoring of F122M will be continued in Cycle 5, in order to continue assessing the state of the POM and the internal contaminants on the CCD windows. However, the method of monitoring may be varied: the possibility of using a line source instead of a spectrophotometric standard is being investigated.
**RAMP PROPOSAL: INTERNALS (6140)**

**Purpose:**
Calibrate the ramp filters (LRFs) and provide updated apertures for those segments of the LRFs used in the Cycle 4 GO/GTO science programs.

**Description:**
This internal program consisted of three parts: visflats crossed with narrow band filters, direct images (visflats) of the ramps, and earthflats with the ramps. The earthflats and ramp visflats were used to verify the alignment of the cal-channel illumination and determine the necessary aperture database updates. The LRF visflats crossed with narrowband filters data will be used in future studies to check the narrowband filter bandpasses. An external portion to the proposal was initially planned but deferred to Cycle 5.

**Products:**
Updates to the aperture tables in the Project Database, the Instrument Handbook, and the Data Handbook, have been completed. A presentation on the status of the LRF calibration was made at the May 1995 HST Calibration Workshop and is available on WWW. An Instrument Science Report is being prepared.

**Accuracy Expected:**
Optimum aperture locations for ramp filters are expected to be good to +/- 2”.

**Accuracy Achieved:**
Apertures were determined to ~1”.

**Continuation Plans:**
Plans for Cycle 5 include monitoring the LRF wavelength stability by obtaining ramp visflats crossed with other filters and designing a proposal to photometrically calibrate the filters.
POLARIZATION PROPOSAL (5574)

Purpose: Verify apertures and provide in-flight polarimetry calibration for 3-CCD and 1-CCD polarization modes of WFPC2.

Description:

Unpolarized and polarized targets were observed (NGC 4147, RMon, G191B2B, and BD+64D106). In the first mode, the target was imaged on each CCD which, with the quad filter POLQ selected, corresponded to a different relative polarization angle. The second mode required two additional observations on WF2, through two partially rotated POLQ filter positions, to yield two different relative polarization angles on the same CCD WF2. Addition of the WF2 observation from the unrotated POLQ yielded three relative polarization angles in the same camera (WF2).

The standard star provides a spectrophotometric calibration and the field, a globular cluster, provides a measure of the uniformity of the instrumental signature over the field of view. These observations are made through each of the four CCD apertures, which correspond to relative pol. angles of 0, 45, 90 and 135, and the two partially rotated POLQ filter selections. Wavelength dependencies are addressed by observing through four broad/medium band filters F336W, F410M, F555W, F675W and F814W. The relative orientation of the polarizers is assumed to be accurate. To establish the zeropoint of the polarizer orientation it is necessary to observe a highly polarized source; a reflection nebula was chosen for its large size and 10-20% polarization. The central source is variable, but the outer regions should be remain relatively constant.

Products: Updates to the aperture tables in the Project Database, the Instrument Handbook, and the Data Handbook, have been completed (see Fig 9 for illustration of polarizer field of views). An ISR is available on observing strategies, including aperture information and more details about the planned Cycle 4 calibration. New flatfields and photometric calibration are currently being completed.

Accuracy Expected:

Aperture locations should be good to ~2”; the anticipated polarimetry accuracy is estimated to be at the few percent level.

Accuracy Achieved:

Aperture locations were determined to 1”; photometric work is in progress.

Continuation Plans:

Standard star observations will be added for F300W, F814W, and possibly other heavily-used filters.
Figure 9: Schematics for the polarizer quad filters and apertures; dashed lines enclose areas that are free of vignetting and cross-talk. Greyscale VISFLAT images of each polarizer crossed with F555W are on the right.
4. References: Documentation of WFPC2 Cycle 4 Calibration Results

The World Wide Web (WWW) pages have become one of the primary methods for disseminating, and maintaining a library of, WFPC2 information. For convenience, the URL’s are given at the end of this report; paper copies of any of the documents are available upon request to help@stsci.edu (410-338-1082).

- WFPC2 Instrument Handbook
- Instrument Science Reports
- Status and Calibration Reports
- WFPC2 Calibration Monitoring Memos
- WFPC2 Exposure Time Estimation Guides
- STAN, The Space Telescope Analysis Newsletter
- Meetings
- WFPC2 Photometry Memos and Reports
- FAQ’s
- WFPC2 WWW Resources, including Software Tools
- Internal Memos: Cycle 4 Calibration Plan Summaries

**WFPC2 Instrument Handbook**

The June 1995 version incorporated many of the Cycle 4 calibration results, including new information on
- filters (linear ramps, polarizers, methane and [OII] quads),
- CCD performance (QE, bright object artifacts, horizontal smearing, residual images, flatfields, dark background, hot pixels, cosmic rays, and CTE problem),
- WFPC2 PSFs (response function, large angle scattering, distortion correction), and
- system throughputs (exposure time estimation, red leaks, contamination effects) calibration (reduction technique, pipeline processing, color transformations, Cycle 5 plans).

**Instrument Science Reports**

Published:
95-06: A Field Guide to WFPC2 Image Anomalies - Biretta, Ritchie, and Rudloff, 08/95

95-04: A Demonstration Analysis Script for Performing Aperture Photometry. A “how-to” guide for photometry with WFPC2 data. - Whitmore and Heyer, 07/95

95-03: Charge Transfer Traps in the WFPC2. - Whitmore and Wiggs, 07/95
95-02: The Geometric Distortion of the WFPC2 Cameras - Roberto Gilmozzi, et al., 06/95

OTA-18: Focus Monitoring and Recommendation for Secondary Mirror Move - Casertano

95-01: WFPC2 Polarization Observations: Strategies, Apertures, and Calibration Plans. - Biretta and Sparks, 02/95

94-03: WFPC2 Pipeline Calibration. - Chris Burrows, 12/94

94-01: Large Angle Scattering in WFPC2 and Horizontal “Smearing” Correction. - John Krist and Chris Burrows, 10/94

Drafts ISRs:
Internal Flatfield Monitoring - Stiavelli

WFPC2 Training Manual - Noll, Gonzaga

Wavelength / Aperture Calibration of the WFPC2 Linear Ramp Filters - Biretta, Ritchie, Baggett, and MacKenty

Time-Dependent Photometry in Synphot for the WFPC2 and WF/PC-1 - Baggett, Sparks, Ritchie, and Mackenty

WFPC2 Throughput Stability in the Ultraviolet - Mackenty and Baggett

Status and Calibration Reports


WFPC2 hot pixel lists on WWW.

WFPC2 Data Quality Checklist: a useful guide to determine the quality of WFPC2 observations.

The WFPC2 Prelaunch Thermal Vacuum Test Report presents the results of the pre-launch system-level T.V. test in May 1993.

The HST Data Handbook contains general HST data reduction information, as well as instrument-specific details (updated version Dec 1995, to be on WWW soon).
**WFPC2 Calibration Monitoring Memos**

History memo, provides chronological information on decontaminations, darks, focus changes, and miscellaneous items.

Photometric monitoring of a standard star in F170W, for all four chips (memo with countrates as well as figures available).

The photometric monitoring of standard stars in PC1 and WF3, for various filters (memo with countrates as well as figures available).

A complete list of the reference files is available for recalibrating WFPC2 data.

List of alternate reference files generated by the WFPC2 IDT available in the STScI archives.

Links are on the WFPC2 Documentation page, under Monitoring Memos:

**WFPC2 Exposure Time Estimation Guides**

The WFPC2 Exposure Time Estimates for Point Sources.

The WFPC2 Exposure Time Estimates for Extended Sources.

**STAN, The Space Telescope Analysis Newsletter**

The Space Telescope Analysis Newsletter is produced monthly and provides HST users with up-to-date calibration and other instrument information. Recent topics have included exposure time estimation tools, new observatory logs, updated synphot tables, new mask files, focus move, new STSDAS wfixup task, etc.

Note: To subscribe or unsubscribe to the STAN email list, send a message to listserv@stsci.edu with the Subject: line blank and the following in the body: [un]subscribe wfpc_news YOUR NAME
Comments, questions, suggestions, etc. can be e-mailed to help@stsci.edu

**Meetings**

Link is on the WFPC2 Documentation page.

TIPS presentations, ~once/month at STScI.

**WFPC2 Photometry Memos and Reports**

The “Photometry with the WFPC2” details the various methods for performing photometric measurements with the WFPC2.
The WFPC2 Photometry Cookbook provides examples of performing photometry on WFPC2 data.

The WFPC2 Photometry site contains an STSDAS demo for performing aperture photometry with the WFPC2.

The “Guide to WFPC2 SYNPHOT Tables” describes the use of the STSDAS task SYNPHOT for WFPC2 photometry.

The WFPC2 Filter Throughput directory contains ASCII versions of the STSDAS throughput tables for all WFPC2 filters.

Dithering: Relationship Between POSTARG’s and CCD Rows/Columns, outlines how to dither WFPC2 exposures by integral pixel values.

**FAQ’s Maintained on WWW**

Questions on WFPC2 Calibration
Questions about WFPC2 Image Displays
Questions about WFPC2 PSFs
Questions about WFPC2 Photometry
Questions about WFPC2 Exposure Times
Questions on WFPC2 Proposal Preparation
Miscellaneous WFPC2 Questions

**WFPC2 WWW Resources and Software Tools**

STScI Homepage:

http://www.stsci.edu/top.html

WFPC2 Homepage:


WFPC2 Documentation page:


Exposure Time Calculator


Linear Ramp Filter Calculator


Frequently accessed URLs (the following are also available via links from the WFPC2 Home and/or Documentation pages)

Exptime calculators:
http://www.stsci.edu/ftp/instrument_news/WFPC2/Wfpc2_etc/wfpc2_point.html

**Internal Memos**
